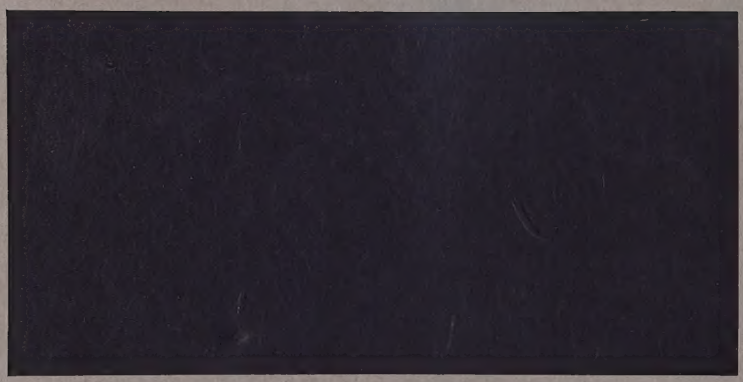
INSTRUCTION MANUAL

POWER SUPPLY

MODEL 212AK

SERIAL No. _____

ELECTRONIC
MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN NEW JERSEY



REGATRON

PROGRAMMABLE

POWER SUPPLY

MODEL 212AK

SERIAL No. _____

ELECTRONIC

MEASUREMENTS

COMPANY, INCORPORATED

EATONTOWN · NEW JERSEY

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2. On receipt of shipping instructions, forward the apparatus to us, prepaid, and we will make repairs and adjustments immediately at the factory.
3. If the fault has been caused by misuse, or abnormal conditions of operation, as disclosed by our examination, repairs will be billed at cost. In this case, an estimate of the cost will be submitted before work is started.

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REGATRON MODEL 212A
TABLE OF SPECIFICATIONS

OUTPUT
0 to 100 volts
0 to 100 milliamperes

REGULATION
Line—0.15% or 0.05 volts, whichever is greater, for line change from 105 to 125 volts ac, 50-60 cps.
Load—0.1% or 0.05 volts, whichever is greater, no load to full load.

REGULATION WITH CHOPPER-STABILIZATION
(Models 212AK and 212AMK)
Line or Load—0.01% or 0.003 volt, whichever is greater.

STABILITY—Within 0.1% or 50 millivolts, whichever is greater, in 8 hours after 30 minutes warmup, under fixed line, load, and temperature conditions, with precision high stability external programming resistor.

STABILITY WITH CHOPPER STABILIZATION—0.05% + 2 millivolts, same conditions as above.

RIPPLE—½ millivolt RMS maximum, with positive or negative output grounded.

INTERNAL IMPEDANCE—Less than .01 ohm at low audio frequencies; 0.1 ohm to 10 KC; 1 ohm to 40 KC.

TRANSIENT RESPONSE—For step change from no load to full, or full to no load, output recovers to within dc regulation limits of initial value within 1 millisecond.

OVERVOLTAGE CAPABILITY—See paragraph 2-10.

REMOTE PROGRAMMING RESISTANCE—1,000 ohms per volt of output.

AMBIENT TEMPERATURE RANGE— —20°C to +45°C.

OUTPUT POLARITY—Panel switch for positive or negative ground or floating output.

CIRCUIT PROTECTION—Input ac line fused, dc output fused.

TERMINATIONS—Front: 5-way insulated binding posts. Rear: barrier-type terminal strips. Line cord is 3-conductor type.

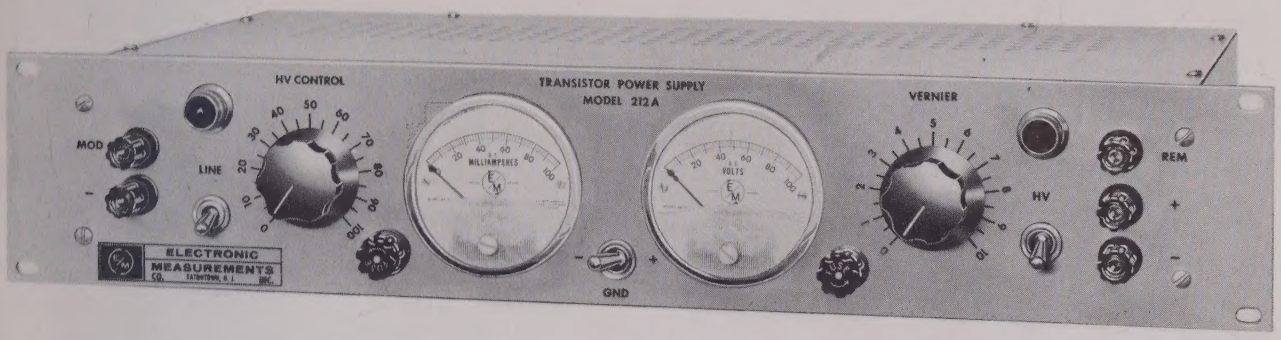
CONTROLS—Main control and 10-volt vernier are of wirewound type. Panel calibration is approximate.

MOUNTING—Unit fits 19″ standard racks and is equipped with rubber feet for table mounting. Top and bottom are protected by perforated metal covers.

FINISH—Smooth gray semi-gloss enamel Class 2 per MIL-E-15090.

DIMENSIONS—3½ inches high, 9½ inches deep, 19 inches wide.

WEIGHT—14 pounds approx.



PART 1 OF THIS MANUAL DESCRIBES THIS POWER SUPPLY.

PART 2 GIVES COMPLETE OPERATING INSTRUCTIONS.

PART 3 DESCRIBES THE CIRCUITRY.

PART 4 COVERS MAINTENANCE.

PART 5 CONTAINS THE PARTS LIST AND SCHEMATIC DIAGRAM.

PART 1
DESCRIPTION

1-1. REGATRON Model 212A Programmable Power Supply is a wide-range source of voltage-regulated d-c power designed for use with transistors and for other applications requiring stable low voltages, such as bridges and strain gauges. Output is continuously adjustable from 0 to 100 volts, and a vernier permits precise selection of output down to a fraction of a volt. Maximum current is 100 milliamperes. Further detailed performance data is presented in the Specifications Table on the opposite page.

1-2. PROGRAMMING. The output voltage of this power supply can be controlled remotely, or programmed, with a low power (1 watt) resistor connected to the REM and + output terminals. Output voltage then depends directly on the value of the programming resistor in the ratio of 1 volt per 1,000 ohms. This relationship remains constant over the entire output voltage range, even at a fraction of a volt. In programmed operation, regulation and stability are maintained within specified ratings. See paragraph 2-7 for instructions on programmed operation.

1-3. OVERVOLTAGE. Model 212A is capable of voltage output nearly three times greater than the specified maximum of 100 volts, at reduced current demands. See paragraph 2-10 for instructions on overvoltage operation.

1-4. MODULATION. Output can be modulated with a signal up to 10 kc in frequency, depending on operating conditions. See paragraph 2-11 for modulation input instructions.

1-5. CONSTANT-CURRENT OUTPUT. This power supply can be converted from constant-voltage to constant-current output by means of a simple external connection. See paragraph 2-15.

1-6. CHOPPER STABILIZATION. For units originally supplied without chopper stabilization, a conversion kit is available to incorporate this feature, or the unit may be returned to the factory for conversion.

1-7. STANDARD VERSIONS. Model 212A is available in the following standard optional versions:

212A —without panel meters
212AM —with panel voltmeter and milliameter
212AK —without meters, with chopper-stabilization
212AMK—with meters, with chopper-stabilization

This instruction manual is applicable to all the above standard versions.

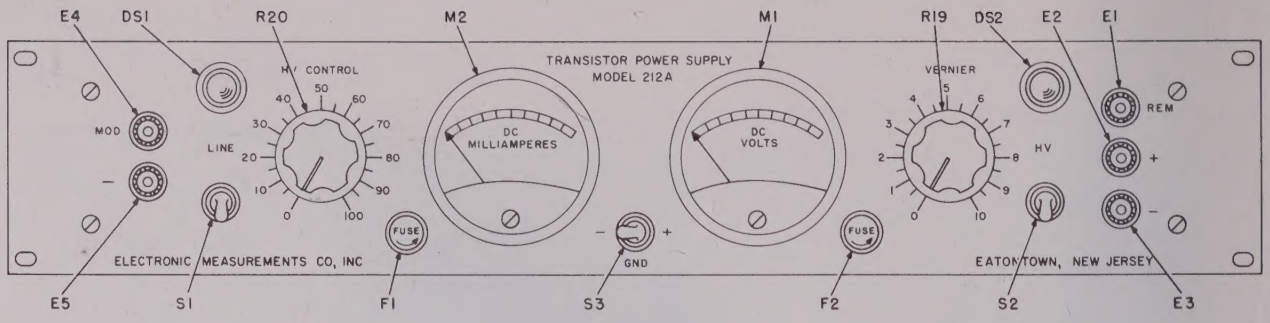


Figure 2-1. Front Panel.

PART 2
OPERATION

2-1. INSTALLATION. This unit operates on 105 to 125 volts, 50 to 60 cycles, single phase ac. Input power required is 97 watts, 106 volt-amperes.

The equipment may be table or rack mounted in a standard 19-inch rack. The rubber mounting feet may be removed from the bottom cover if they interfere with other rack-mounted equipment. Sufficient clearance should be allowed above and below the unit to provide adequate ventilation. The top dust-cover may be removed, if desired, to increase the ventilation.

2-2. CONTROLS AND TERMINATIONS.
See figure 2-1.

a. LINE switch: controls a-c line input.
b. HV switch: controls regulated d-c output.
c. GND switch: permits positive or negative chassis ground or floating output.
d. HV CONTROL: for adjustment of output voltage, calibrated to dial markings on panel.
e. VERNIER: for continuous fine adjustment through 10 volts. VERNIER and HV CONTROL settings are additive.
f. MOD and — terminals: for modulation input. See paragraph 2-11.
g. + and — terminals: for connection of load.
h. REM terminal: with + terminal, for programming resistor connection.
i. NULL adjustment: (on chassis) for zeroing of balanced input detector. See paragraph 4-2.
j. CAL adjustment: (on chassis) for adjustment of output to panel markings or for exact 1,000 ohms per volt programmed operation. See paragraph 4-3.

2-3. FUSES. This unit contains the following fuses mounted on the front panel:

F1—2 amps (at left), in a-c line input circuit
F2—1/8 amp (at right), in + d-c circuit, to protect against short circuit or excess load across output

2-4. PRELIMINARY. Before connecting to ac power, check that:

a. LINE switch is off (down).
b. HV switch is off (down).
c. HV CONTROL and VERNIER are at minimum, fully counter-clockwise.
d. GND switch is at desired condition. Center position provides floating output, the — position ties black lower post to chassis, the + position ties the red + post to chassis.

2-5. LINE AND LOAD CONNECTIONS

a. Connect line cord to ac power outlet.
b. Connect load to + and — output posts. It should be noted that the regulation of this unit is measured at the output posts. To maintain the specified regulation in actual service, the load wires must be heavy enough to prevent substantial voltage drops between the output posts and the load.

2-6. LOCAL OPERATION

a. Throw LINE switch on: green indicator should light.
b. Set HV CONTROL to desired voltage indicated on panel or voltmeter. If greater resolution is desired, this can be a coarse setting. The VERNIER, which is additive, provides the fine setting.

c. Turn VERNIER to precise voltage desired. For an output of 10 volts or less, set HV CONTROL to zero and select output with VERNIER alone to realize greater stability.

d. After one minute, throw HV switch on: red indicator should light. Desired voltage is now applied to load.

NOTE

Always allow a one-minute warmup period from a cold start before throwing HV switch on. This switch, when off, shorts the + and — output posts, thus effectively preventing application of any excess voltages to load during warmup. Subsequently, the HV switch can be thrown on or off with no danger of exceeding the desired output voltage.

2-7. PROGRAMMED OPERATION. As stated in paragraph 1-2, the output of this power supply can be controlled from a remote point, or programmed, with a resistor. For programmed operation, proceed as follows:

a. Throw HV and LINE switches off.

b. Remove the top dust cover.

c. Sever the short jumper between the + and REM posts.

d. Replace the cover.

e. Connect the load and the programming resistor as shown in figure 2-2A. Output voltage depends on programming resistance in the ratio 1:1,000. For example, to obtain 50 volts, use a 50,000 ohm resistor.

f. Throw LINE switch on.

g. Set HV CONTROL and VERNIER to zero.

h. Throw HV switch on. Programmed voltage is now applied to load.

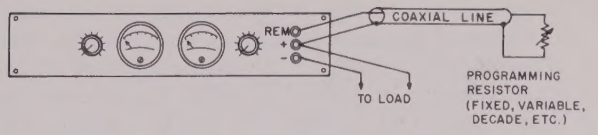
Where both load and programming resistor are at a distance from the power supply, but close to each other, a common + lead may be employed, as in figure 2-2B. This arrangement yields remote sensing for regulation directly at the load by eliminating the effect of voltage drop in the + lead.

To restore the unit to local operation, throw HV and LINE switches off, remove programming resistor connection, re-connect internal jumper between + and REM posts, and follow the procedure in paragraph 2-6.

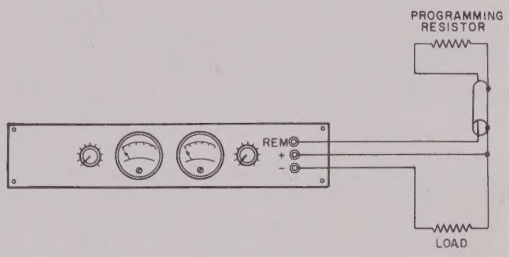
2-8. The following considerations apply to programmed operation:

a. Unless the programming resistor itself is physically shunted across the REM and + terminal posts, it is desirable to use shielded or coaxial cable, as shown in figure 2-2A, to prevent injection of ripple and noise from external sources. An insulated cable such as RG 58/U is recommended because of the fact that the coaxial sheath carries output potential.

b. For long-term or permanent programmed operation it is advisable to short out the internal controls. This will eliminate possible disturbance of programmed voltage by accidental rotation or vibration of the HV CONTROL or VERNIER, and will yield, in general, greater stability.



A. Programmed Operation.



B. Programmed Operation with Remote Sensing.

Figure 2. Internal jumper must be cut for programmed operation.

Programmed operation can be combined with use of the internal controls, when convenient or necessary, merely by disregarding step g. of paragraph 2-7. In this case the value of the programming resistor will be added to the values to which the internal controls are adjusted, and the total resistance will determine output voltage.

2-9. PROGRAMMING SUGGESTIONS. Although the above programming instructions are illustrated with a single, fixed resistor as the remote control, it is evident that variable resistors, driven potentiometers, or fixed resistors wired to stepping switches can be employed to deliver voltages in a wide variety of time/amplitude patterns.

The time required for switching from one programmed voltage to another varies from the seconds range to the milliseconds range, depending upon conditions. Modifications for special switching times are available on special order from the factory.

It is also evident that programming can be manually or automatically actuated. As an example of automatic programming, figure 2-3 illustrates a four-level rotary stepper switch, each level of which controls one Regatron supply. As shown, the entire battery can be stepped through a sequence of four programmed outputs upon command.

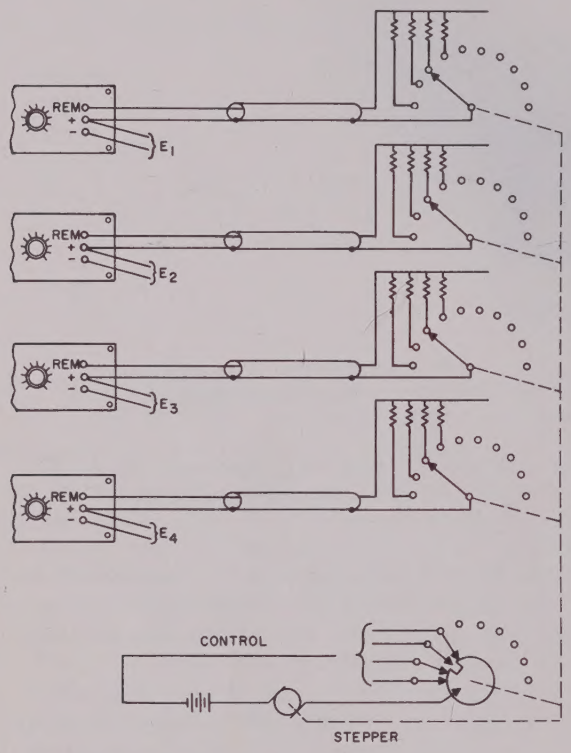


Figure 2-3. Programming with Stepper Switch. Each level controls one Regatron power supply.

In an extensive system, a central board may contain the switches or rheostats for the programming of several Regatron power supplies in different locations. In such a system it is practical to calibrate the control elements directly to dial markings, remembering that the accuracy of calibration depends upon the accuracy of the resistances and/or the dial markings.

2-10. OVERVOLTAGE OPERATION. For overvoltage, an external programming resistor must be employed to substitute for or add to the resistance of the HV CONTROL and VERNIER in order to extend the control resistance range and, therefore, the output range. Figure 2-4 gives the current derating of this unit in overvoltage operation. For example, at 250 volts, current is available up to about 20 ma. This voltage output could be obtained by setting the HV CONTROL and VERNIER to zero, and shunting a 250,000 ohm resistor across the REM and + posts. Alternatively, the controls could be set for 100 volts, with an external 150,000 ohm resistor across the REM and + posts.

2-11. MODULATION. The output of this unit can be modulated by a dc or ac voltage injected via the MOD terminal posts.

DC Offset—A dc offset to a maximum of ± 4 volts can be applied to the MOD input. Transfer gain is 0.9 approx.

AC Signal—Maximum frequency of ac modulation depends upon operating conditions. With no load, best results are obtained with modulation frequencies not exceeding 400 cycles. With a 30 ma load, the time constant across the output permits modulation to 10 kc; when the useful load does not draw the full 30 ma an auxiliary load can be placed in shunt to draw the remainder. It should also be noted that the percentage of modulation at outputs under 10 volts is limited by high ac current flow. For example, a 10 ohm load draws the nominal current maximum of 100 ma at 1 volt output. In such a case, ac modulation could cause the current capability of the power supply to be exceeded and result in a malfunction.

2-12. One side of the MOD input is returned to the negative of output voltage. A grounded modulation input should therefore be used with the GND switch at the — position, since the + position would place one side of the signal source below ground at the potential to which the output of the power supply has been adjusted. If it is desired to use a grounded modulation input with the GND switch at the + position, place a capacitor and 1,000 ohm resistor in series with the MOD input connection; the capacitor should be large enough to pass the lowest desired modulating frequency. A floating modulation input should be used with the GND switch at the + position.

2-13. SMALL SIGNAL MEASUREMENTS. One method for the measurement of transistor parameters requires the superposition of a small ac signal on one of the dc potentials. This unit is particularly suitable for this since the dc voltage may be set independently, and modulation then introduced to provide the required small signal, subject to the instructions given above.

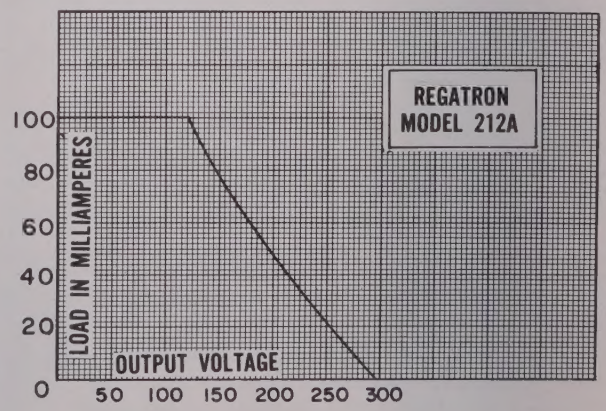


Figure 2-4. Overvoltage operation, showing current deratings.

2-14. OSCILLATION. To make modulation possible the output system of this unit has been made relatively "soft". Because of this, some sensitivity to the type of load is present, and a capacitor of .1 microfarad directly across the output may cause high frequency oscillation. To eliminate this sensitivity, a capacitor of about 20 uf may be connected directly across the output. This, of course, disables the modulation feature except at very low frequencies.

2-15. CONVERSION TO CONSTANT-CURRENT. For conversion from constant-voltage to constant-current output, proceed as follows:

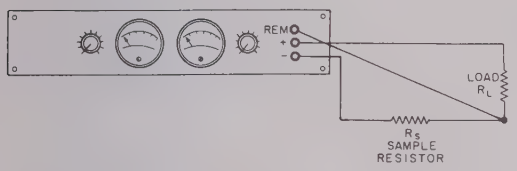


Figure 2-5. Conversion to constant-current operation.

a. Select a sample resistor, R_S in Figure 2-5 below, which will carry the load current and develop a sample voltage for the control system. To determine its value, select a sample voltage. Five to 10 volts is a good range. Although the voltage may be made as high as desired it must be remembered that the sample voltage subtracts from the available output voltage. If E_S is the sample voltage and I_L is the desired load current, then $R_S = \frac{E_S}{I_L}$, where R_S is in ohms and I_L is in amperes. The actual wattage will be $E_S \times I_L$. The resistor used should have a somewhat higher wattage rating.

b. Make connections as shown in Figure 2-5 and set both panel controls to zero.

c. Remove the top cover and sever the short jumper between the REM and + terminal posts. Then replace cover.

d. Throw the LINE switch on.

e. Bring current up to the desired value by turning the VERNIER up to the voltage selected as the sample in step a. above. In constant-current operation the VERNIER is the output control (for sample voltages up to 10 volts).

The conversion described above provides good dc regulation. The ac impedance of the power supply, however, is relatively low, and this should be noted in considering applications. Where output impedance is unimportant, ripple can be reduced somewhat further by connecting a capacitor across the load of between 0.1 and several microfarads.

2-16. CHOPPER STABILIZED OPERATION. As stated n the specifications table, this unit achieves regulation of 0.01% or 3 mv, and stability of 0.05% + 2 mv for 8-hours when equipped with chopper stabilization. Although both ratings are conservative, note that the stability figure is specified with the unit in programmed operation, using an external resistor of high electrical and (in the case of a variable resistor) high mechanical stability. This rating can be realized only in such operation, and with the internal controls shorted out or set to zero to prevent them from contributing variations resulting from accidental rotation or vibration.

PART 3
CIRCUITRY

Note: Circuit references are made to the schematic diagram, except where indicated.

3-1. GENERAL. This power supply employs a full-wave rectifier, the positive output of which is applied to series amplifiers controlled by the regulator loop. The resulting regulated dc voltage constitutes the output.

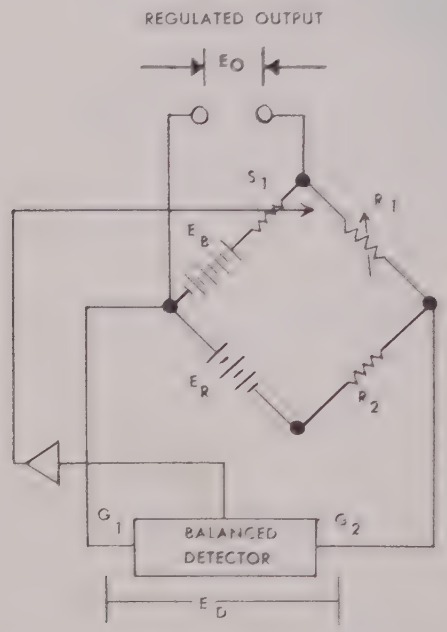


Figure 3-1. Output control configuration.

3-2. CONTROL SYSTEM, LOCAL AND PROGRAMMED. Figure 3-1 illustrates the output control configuration in simplified form. If inputs G_1 and G_2 are equal ($E_D = 0$) then:

$$\frac{E_0}{E_R} = \frac{R_1}{R_2} \text{ and } E_0 = E_R \times \frac{R_1}{R_2}$$

where E_0 = regulated output voltage
E_R = internal reference voltage
and R_2 is a fixed resistor.

Since E_R and R_2 are constant, $E_0 = KR_1$; or, the output voltage is dependent only upon the value of R_1 which, in local operation of the power supply, consists of the HV CONTROL and VERNIER. In programmed operation, R_1 is the remote programming resistor. In either local or programmed operation, the voltage output = $0.001R_1$, or, 1,000 ohms control resistance per volt of output.

In practice, R_2 can be adjusted with the CAL control (on the chassis) for exact 1,000 ohms-per-volt programmed operation, or to calibrate output with panel dial markings.

3-3. REGULATOR SYSTEM, GENERAL. The regulator system employs a balanced input detector, V8, connected from the zero point of the input bleeder to the negative reference point (minus) to detect departures from balance. The amplifier error is applied to a high gain amplifier, V5, which drives the grids of the series amplifiers V9 and V10 in such a manner as to overcome the error. Because of the high gain of the system the error at equilibrium is very small. A gas tube, V4, maintains a very stable reference potential, and v/r tubes V2 and V3 maintain steady service potentials for the regulator tubes.

3-4. UNREGULATED DC SUPPLY. The main dc supply employs a 5U4GB (V1) for full-wave rectification, with filtering provided by a 120 UF electrolytic capacitor, C2. This is the source of voltage for the output and for the plates of V8. A 150 volt negative supply is also derived from a series of selenium rectifiers CR1, CR2, and CR3, and filtered by an 80 UF capacitor, C1.

3-5. REFERENCE. The internal reference, also employed for the cathode of V5, is a gas-filled 85A2, V4, which yields a stable voltage of approximately —85 volts. A stable —150 volts is obtained across an 0A2, V3, and +150 volts across an 0B2, V2.

3-6. SERIES AMPLIFIERS. Paralleled 6L6 beam power pentodes, V9 and V10, are employed as series amplifiers. These act as variable conductances. Positive output is obtained from the cathodes; control grids are direct-coupled to the plate of the starved amplifier V5. With the HV switch open, the plates of V9 and V10 are removed from + high voltage.

3-7. BALANCED INPUT DETECTOR. A 12AX7 cathode-coupled amplifier V8 is employed as a balanced input detector, grid 2 of which is effectively at the positive of the reference potential, and grid 7 at the other null point on the opposite side of the control bridge. Plate supply is taken from V2, and cathodes are returned through R12 to V3. The NULL control R13 permits setting of the balanced input detector to zero difference between grids. Output from plate 1 is applied across a coupling and voltage divider network consisting of EM10 glow discharge regulator tubes V6 and V7 and resistors R8 and R7. The glow tubes couple plate potential to the grid of V5, maintaining a constant voltage drop which permits the grid to follow the potential at the plate of V8, and thus constituting an effective dc coupling which avoids any substantial loss of gain.

3-8. DRIVER AMPLIFIER. This stage employs a 6AU6 pentode in high gain, low current operation. Output from V5 is direct-coupled to the grids of the series tubes, V9 and V10.

3-9. CHOPPER STABILIZATION. On units so equipped, the chopper stabilizer is installed across the grids of the direct-coupled balanced input detector. Without chopper stabilization, this stage is subject to zero offset, with the result that output voltage may drift up to .1% or 50 millivolts for 8-hours. The chopper unit, utilizing a contact modulator (chopper), continually samples the offset at grid 7 of V8, chops it to produce a square wave, amplifies, rectifies, and filters it, and applies the resulting correction signal via reference grid 7 to the regulator system to reduce the net offset to a vanishingly small value. The chopper-stabilizer adds a gain of approximately 1000 to the regulator system. Both regulation and stability improve as given in the Specifications Table.

3-10. MOD AND OUTPUT CIRCUITRY. The MOD input is applied through R9, a parasitic suppressor, to reference grid 7 of the balanced input detector V8; the MOD—terminal is returned to negative.

This power supply is supplied with a short jumper connected internally between the REM and + terminals for local operation. Severing this jumper permits the use of an external programming resistor in series with the internal controls.

Resistor R24 and capacitor C7 adjust the feedback loop characteristic for stable operation. Capacitor C6 feeds ac signals directly to the input grid of V8. In addition, a semiconductor F6 diode, CR4, is connected across the output to present a low impedance to reverse voltages which may occur when the unit is shut off, and thus to protect the external load.

PART 4
MAINTENANCE

Attention is called to the Warranty under which this equipment is sold, to be found opposite the Table of Contents page at the front of this book.

4-1. PARTS REPLACEMENT. An electrical parts list accompanies the schematic diagram in Part 5 of this book, and, along with the parts location illustrations, will identify all parts to be replaced. In general, replacement parts are completely defined by the values and tolerances indicated on the parts list. The following components, however, require special attention:

a. V2, V3, and V8—Replacement of any of these tubes will affect null balance, which should therefore be readjusted as per paragraph 4-2.

b. V4—Replacement of the 85A2 will change the internal reference voltage somewhat, and necessitate recalibration as per paragraph 4-3. If the replacement 85A2 does not yield approximately correct calibration, or proves unstable, a satisfactory tube will be furnished by the factory upon request.

c. HV VOLTAGE and VERNIER controls—If either of these wirewound potentiometers is defective, it is advisable to obtain an exact replacement. If none is available locally, an order should be addressed to the factory. Any temporary substitute potentiometer should provide an arc of 280° effective rotation for the panel dial markings to represent output correctly.

d. V9 and V10—Because of large mu variations among 6L6 tubes, some replacements will not permit control, particularly at higher line voltages. Some selection of 6L6 replacements may occasionally be necessary. See paragraph 4-9.

4-2. NULL ADJUSTMENT. The NULL control, found on the chassis, permits adjustment of the balanced input detector to null, or zero level. This adjustment, which holds over the entire operating range, is made as follows:

a. Remove the top cover.

b. With the HV CONTROL and VERNIER at zero, throw the LINE switch on. After a minute (from cold start) throw the HV switch on.

c. Connect a voltmeter across the output + and — posts. Use 3 volt dc scale or lower.

d. Adjust the NULL control for zero on the meter. A very sensitive indication can be obtained by alternately connecting and disconnecting the meter lead.

4-3. CALIBRATION. The CAL control, also found on the chassis, requires adjustment for any one of three reasons:

for close agreement between panel markings and output, or

for exact 1,000 ohms-per-volt ratio in programmed output, or

for recalibration to either of the above after replacement of V4.

This adjustment can be performed in either of two ways: with an accurate voltmeter or with an external, precise source of voltage.

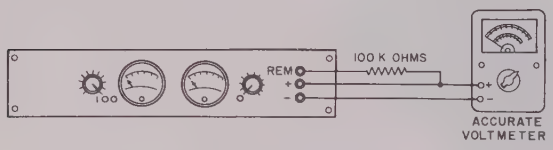


Figure 4-1A. Calibration—With Accurate Voltmeter for exact 1000 ohms-per-volt programming.

4-4. If an accurate voltmeter is employed, proceed as follows, referring to figure 4-1A.

a. Remove top cover. Connect meter across + and — output terminals.

b. To calibrate panel markings, turn VERNIER to zero and the HV CONTROL to 100. Throw LINE, then HV switches on, and adjust CAL control (on chassis) for a 100 volt reading on the external voltmeter.

c. To calibrate for exact 1000 ohms-per-volt programmed output, turn VERNIER and HV CONTROL to zero. Set up for programming and connect a 100,000 ohm resistor across the REM and + terminals. Throw LINE, then HV switches on, and adjust CAL control for 100 volts on the external voltmeter.

4-5. If an external, precise source of voltage is employed, proceed as follows, referring to figure 4-1B.

a. Connect the negative outputs of the unit and the external voltage source together.

b. Connect an accurate voltmeter between the positive terminals of the Regatron unit and the external source.

c. Set the external source to exactly 100 volts.

d. To calibrate panel markings, turn VERNIER to zero and the HV CONTROL to 100. Throw LINE, then HV switches on, and adjust CAL control for a zero reading on the external voltmeter. Use the lowest dc meter range available.

e. To calibrate for exact 1000 ohms-per-volt programmed output, turn VERNIER and HV CONTROL to zero. Set up for programming and connect a 100,000 ohm resistor across REM and + terminals. Throw LINE, then HV switches on, and adjust CAL control for zero on the external meter.

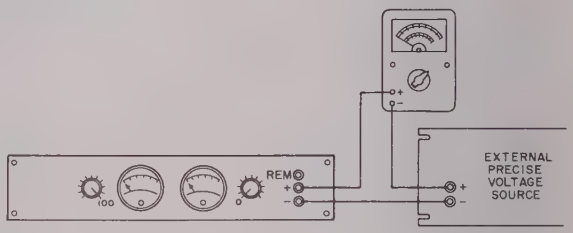


Figure 4-1B. Calibration — With External, Precise Voltage Source.

4-6. TABLE OF RESISTANCES. Conditions of measurement:

a. A-c line cord not connected to power.
b. No load connected.
c. LINE and HV switches off. GND switch at –.
d. HV CONTROL at 0. VERNIER at 0.
e. Readings from indicated tube pins to B- post.

RESISTANCES

TUBE	PIN								
	1	2	3	4	5	6	7	8	9
V1	—	100 meg	∞	90	—	90	—	∞	
V2	—	—	—	—	∞	—	0		
V3	—	65K	—	—	0	—	65K		
V4	0	60K	—	—	—	—	60K		
V5	1 meg	68K	0	0	∞	180K	68K		
V6	At pin 1 of V8: ∞. At junction V6-V7: ∞								
V7	At junction V7-R8: 1 meg								
V8	∞	1200	210K	0	0	∞	100K	220K	0
V9	—	0	∞	∞	∞	30	0	0.5	
V10	—	0	∞	∞	∞	∞	0	0.5	

4-7. TABLE OF VOLTAGES. Conditions of measurement:

a. Line input 115 volts ac. LINE and HV switches on.
b. HV CONTROL at 90, VERNIER at 10.
c. No load connected.
d. GND switch at –.
e. Readings from indicated tube pin to — post.

VOLTAGES

All voltages are dc unless noted.

TUBE	PIN								
	1	2	3	4	5	6	7	8	9
V1	—	330	0	280 AC	—	280 AC	—	330	
V2	108	—	—	—	108	—	0		
V3	0	—150	—	—150	0	—	—150		
V4	0	—85*	—	—85*	—	—	—85*		
V5	—85*	—85*	6.3 AC	6.3 AC	67	—51	—85*		
V6	At pin 1 of V8: 41. At junction V6-V7: –19.								
V7	At junction V7-R8: –80.								
V8	41	0	0.4	6.3 AC	6.3 AC	108	0	0.8	0
V9	—	6.3 AC	330	330	65	103†	0	103	
V10	—	6.3 AC	330	330	65	103†	0	103	

*Approximate. Values range from 83 to 87 volts.
†Tie point only.

4-8. TROUBLE-SHOOTING TABLE. Referenced below are several possible symptoms of troubles which can develop, with their most likely causes, and remedies. This table is intended to serve as a brief guide in trouble shooting Model 212A.

SYMPTOM	CAUSE	REMEDY
1. Unit is dead when LINE switch is thrown on.	a. Fuse F1 blown. b. Fuse F1 open, defective.	a. Replace with 2 amp fuse. b. Check F1 for continuity and replace if necessary.
2. Fuse F1 blows repeatedly.	a. 5U4GB rectifier V1 shorted. b. 8J1 diodes CR1, CR2, or CR3 shorted.	a. Replace b. Replace
3. DC fuse F2 blows, output to zero.	a. Short circut load. b. Overload, above 100 ma. c. Fuse F2 open, defective. d. HV CONTROL or VERNIER potentiometer open.	a. Check load. b. Check load. c. Check F2 for continuity and replace if necessary. d. Check R19, R20 for resistance. See paragraph 4-1.
4. No control of output, voltmeter pins at top of scale.	a. 6L6 series amplifier V9 or V10 shorted. b. 6AU6 amplifier V5 inoperative. c. 0A2 v/r tube V3 open. d. 85A2 reference tube V4 open.	a. Replace. See paragraph 4-1. b. Replace c. Replace d. Replace. See paragraph 4-1.
5. No control of output, voltmeter at zero, fuse F2 not blown.	a. 6L6 series amplifier V9 or V10 defective b. F6 diode CR4 shorted (across output terminals) c. 0B2 v/r tube V2 open d. 12AX7 balanced input detector V8 defective	a. Replace. See paragraph 4-1. b. Replace c. Replace d. Replace
6. Voltmeter indication disagrees with control settings at full scale.		a. Re-calibration necessary.
7. Meter reads lower than controls but recalibration impossible or out of CAL range.	a. 85A2 reference tube V4 shifted voltage. b. 0A2 defective.	a. Replace. See paragraph 4-1. Re-calibrate. b. Replace
8. Poor line regulation	a. Defective V1, V2, V3, V4, or V8.	a. Replace. See paragraph 4-1.
9. Poor load regulation	a. Poor load connections b. 6L6 series amplifier V9 or V10 defective c. Defective V2, V3, or V4	a. Check external load connections. b. Replace. See paragraph 4-9. c. Replace. See paragraph 4-1.
10. NULL adjustment impossible	a. Fuse F2 blown b. Defective V2, V3, V4, V6, V7, or V8	a. Replace b. Replace
11. High ripple	a. Defective V3, V4, or V8 b. Defective C1 or C2	a. Replace b. Replace.
12. Oscillation	a. See paragraph 2-14	

4-9. SERIES TUBE FAULTS. In selecting replacement 6L6 series tubes, or when a malfunction appears to result from a faulty series tube, the following procedure is recommended:

a. Remove one series tube.

b. Turn the unit on (paragraph 2-6) and apply a load of 50 ma at 100 volts. Check ripple and regulation.

c. Remove the first series tube and repeat with the other tube in the second socket.

d. If a test yields a faulty result, repeat it with a tube known to be good.

e. If a favorable result is obtained, it may be assumed that the previous tube is faulty. If this proves wrong, check for faults in the associated circuits.

4-10. NULL ADJUSTMENT FOR CHOPPER-STABILIZED UNITS.

a. With unit set for zero output connect a 100 millivolt meter across the output + and — terminals.

b. Rotate the NULL control to maximum in one direction and read the output in millivolts. Rotate NULL control to maximum in the opposite direction and read the output in millivolts. The difference between the two extremes should be less than 3 millivolts.

c. Rotate control to approximate center of range. When adjusted as described above the zero offset of the power supply should not exceed 1 millivolt. Usually, if this occurs, it is due to excessive grid current in the 12AY7. The tube should be changed and one used providing less than the specified offset.

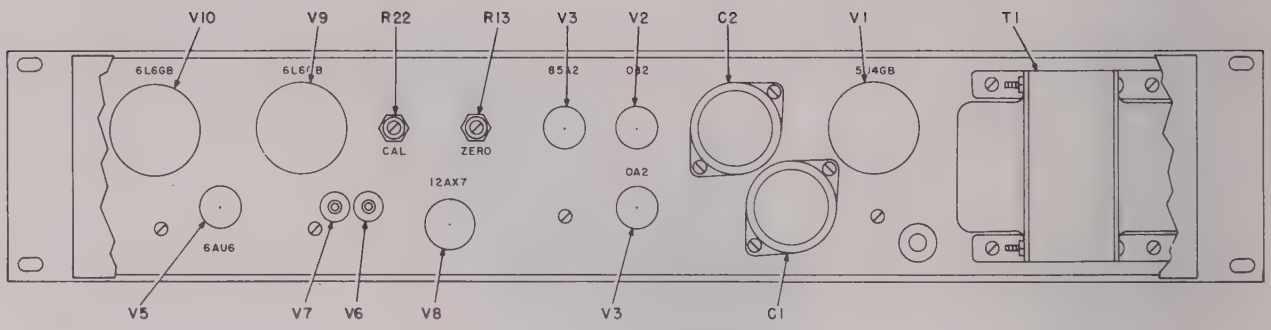


Figure 5-1. Parts Locations.

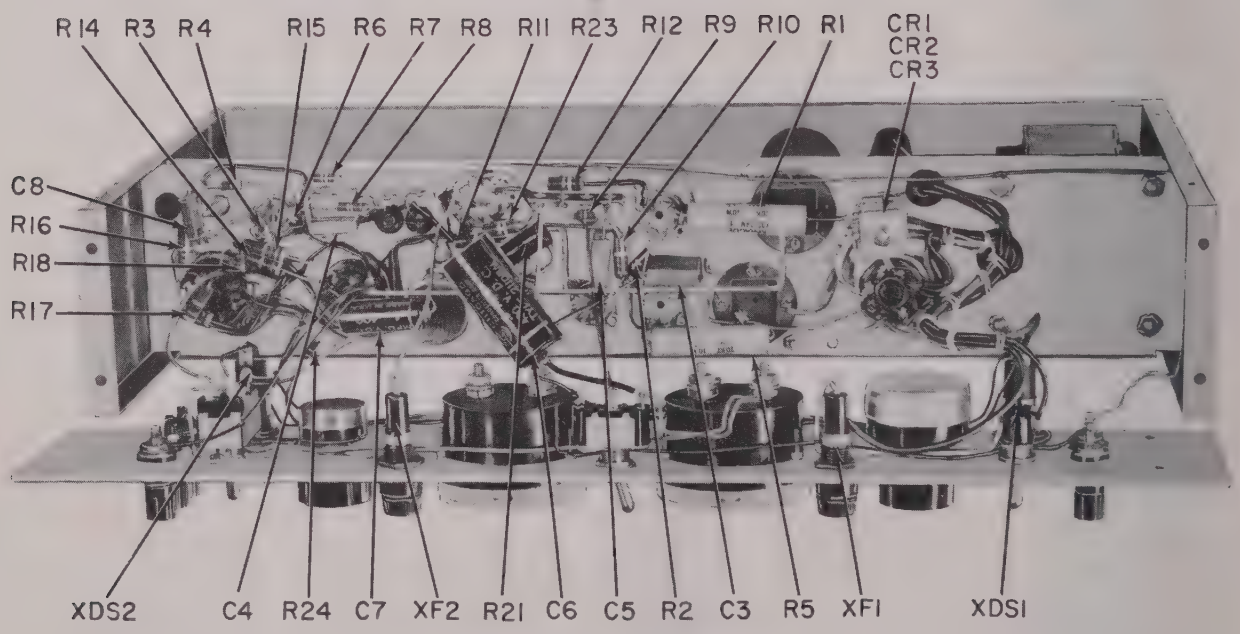


Figure 5-2. Parts Locations.

PART 5
PARTS LISTS AND LOCATIONS

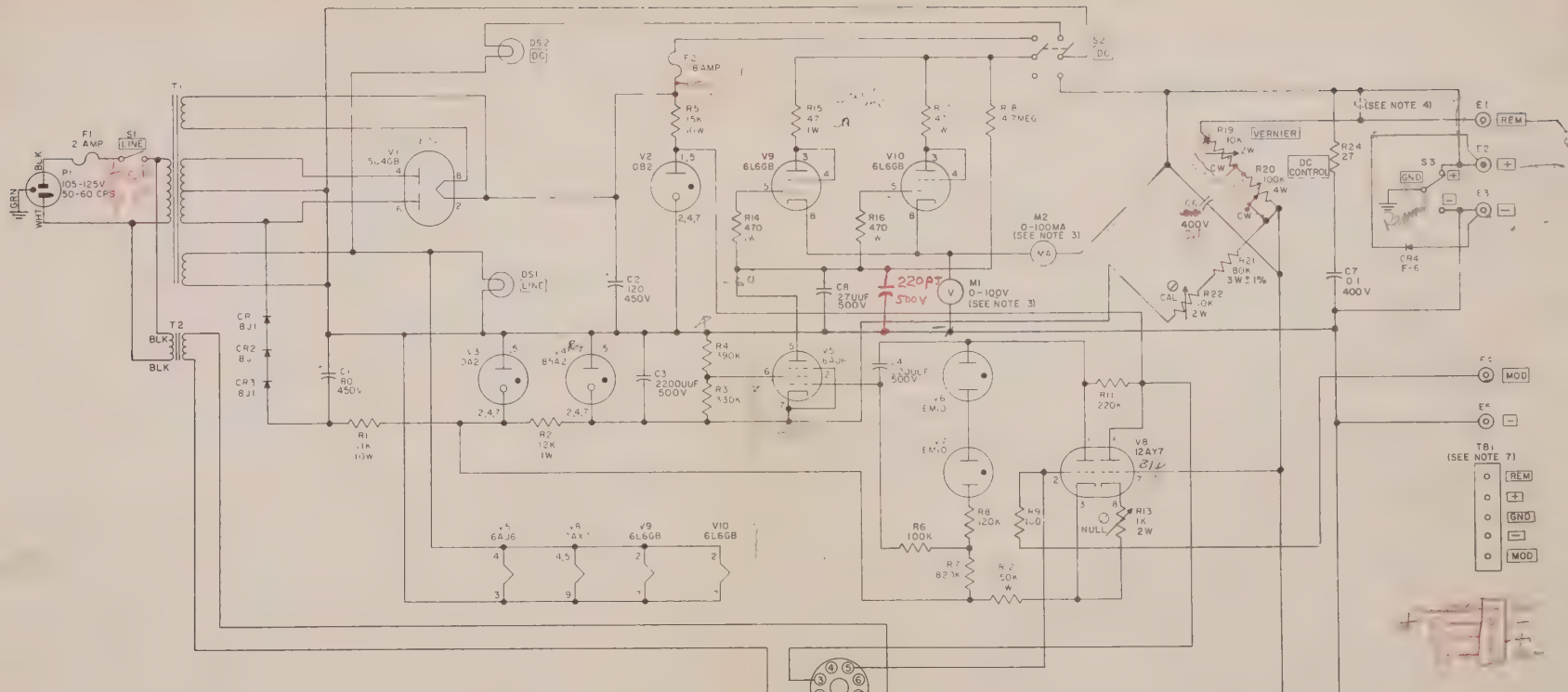
CIRCUIT SYMBOL	DESCRIPTION	TYPE OR PART NO.	MFR. SYMBOL
*C1	Capacitor, electrolytic, 80 UFD, 450 VDC	TM 80/450	PY
*C2	Capacitor, electrolytic, 120 UFD, 450 VDC	TM 120/450	PY
C3, 5	Capacitor, mica 2200 UUFD, 500 VDC ±5%	CM20E222-J	MICAMOLD
C4	Capacitor, mica 220 UUFD, 500 VDC ±5%	CM20D221-J	MICAMOLD
C6	Capacitor, Mylar .5 UFD, 400 VDC	Type 2110BM	CCC
C7	Capacitor, molded tub, .1 UFD, 400 VDC ±20%	IMP .1/400	PY
C8	Capacitor, mica 27 UUFD, 500 VDC ±5%	CM19B270-J	MICAMOLD
*CR1	Rectifier, selenium	8J1	RR
*CR2	Rectifier, selenium	8J1	RR
*CR3	Rectifier, selenium	8J1	RR
*CR4	Rectifier, silicon	F6	ST
DS1, 2	Lamp incandescent, 6 volt	#44	GE
F1	Fuse, 2 amps	3AG-2	SGTM
F2	Fuse, 1/8 amp	3AG-1/8	SGTM
*M1	Voltmeter, 0-100 VDC, ±2% full scale	Model MM2/100V	EMC
*M2	Milliammeter, 0-100 MA DC, ±2% full scale	Model MM2/100ma	EMC
R1	Resistor, fixed, WW, 11K ±5%, 10W	10KT	SPR
R2	Resistor, fixed, comp. 12K ±5%, 1W	Type GB	AB
R3	Resistor, fixed, comp. 330K ±10%, ½W	Type EB	AB
R4	Resistor, fixed, comp. 390K ±10%, ½W	Type EB	AB
R5	Resistor, fixed, WW 15K ±5%, 10W	10KT	SPR
R6	Resistor, fixed, comp. 100K ±10%, ½W	Type EB	AB
R7	Resistor, fixed, comp. 820K ±10%, ½W	Type EB	AB
R8, 23	Resistor, fixed, comp. 120K ±10%, ½W	Type EB	AB
R9	Resistor, fixed, comp. 100, ±10%, ½W	Type EB	AB
R10	Resistor, fixed, comp. 1.2K ±%, 1W	Type GB	AB
R11	Resistor, fixed, comp. 220K ±10%, ½W	Type EB	AB
R12	Resistor, fixed, comp. 150K ±5%, 1W	Type GB	AB
R13	Resistor, variable, WW, 1K ±5%, 2W, 1/8" slotted shaft	CM18922	CLARO
R14, 16	Resistor, fixed, comp. 470, 1W, ±10%	Type GB	AB
R15, 17	Resistor, fixed, comp. 47, 1W, ±10%	Type GB	AB
R18	Resistor, fixed, comp. 4.7 Meg, ½W, ±10%	Type EB	AB
*R19	Resistor, variable, WW, 10K ±5%, 2W, ½" Shaft	CM21189	CLARO
*R20	Resistor, variable, WW, 100K ±5%, 4W, ½" shaft	CM18927	CLARO
*R21	Resistor, fixed, WW, 80K ±1%, 3W	Type P3W	PR
R22	Resistor, variable, WW, 10K ±5%, 2W, 1/8" slotted shaft	CM18924	CLARO
R24	Resistor, fixed, comp. 27, ½W, ±10%	Type EB	AB
*S1	Switch, toggle SPST	160-63	CE
*S2	Switch toggle DPDT	2GL53-63	CE
S3	Switch, toggle SPDT, center off position	2FC63-63	CE
*T1	Transformer, plate and filament	5012	EMC
*V1	Tube 5U4 GB	5U4GB	SYL
*V2	Tube OB2	OB2	RCA
*V3	Tube OA2	OA2	RCA
*V4	Tube OG3/85A2	OG3/85A2	AMPX
*V5	Tube 6AU6	6AU6	RCA
*V6, 7	Tube, neon glow	EM-10	EMC
*V8	Tube, 12AX7	12AX7	RCA
*V9, 10	Tube 6L6GB	6L6GB	SYL

NOTE: A parts list for the chopper-stabilizer unit used in Models 212AK, AMK is found on the back of the schematic diagram of the chopper-stabilized version.

*Recommended spares.

MANUFACTURERS' SYMBOLS

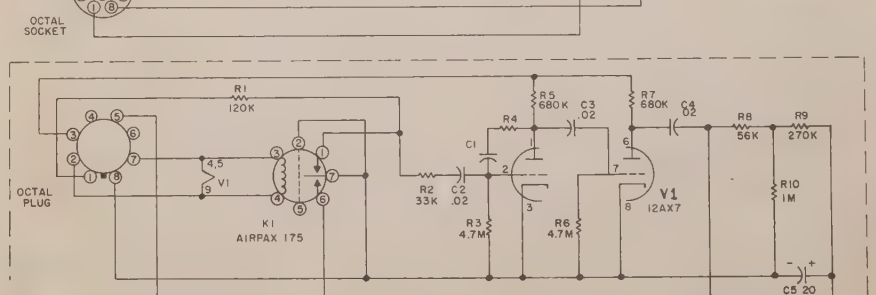
MFG SYMBOL	NAME	ADDRESS
AB	Allen-Bradley Company	Milwaukee 4, Wisconsin
AMP	Amperite Company, Inc.	New York 12, N. Y.
AMPX	Amperex Electronic Corporation	Hicksville, L. I., N. Y.
AEC	Amphenol Electronics Corporation	Chicago 50, Ill.
ARCO	Arco Electronics, Inc.	New York 13, N. Y.
BC	Barber-Colman Company	Rockford, Ill.
BRY	Bryant Electric Company	Bridgeport 2, Conn.
CCC	Chicago Condenser Corporation	Chicago 47, Ill.
CE	Carling Electric, Inc.	West Hartford 10, Conn.
CJ	Cinch-Jones Manufacturing Company	Chicago 24, Ill.
CLARO	Clarostat Manufacturing Co., Inc.	Dover, New Hampshire
CR	Consolidated Resistance Co. of America	Yonkers, New York
CTL	Centralab	Milwaukee 1, Wis.
DA	De Jur Amsco Corporation	Long Island City 1, N. Y.
DMC	Drake Manufacturing Company	Chicago 22, Ill.
EBY	Hugh H. Eby Company	Philadelphia 24, Pa.
EFJ	E. F. Johnson Company	Waseca, Minn.
EMC	Electronic Measurements Co., Inc.	Eatontown, N. J.
FRK	Frako Condenser & Apparatus, Inc.	Teningen, West Germany
GE	General Electric Company	Lamp Division, New York, N. Y.
GH	Grayhill	La Grange, Ill.
GR	General Radio Company	Ridgefield, N. J.
IRC	International Resistance Company	Philadelphia 8, Pa.
KK	Kurz-Kasch, Inc.	Dayton 1, Ohio
LI	Littelfuse, Inc.	Des Plaines, Ill.
NE	National Electronics, Inc.	Geneva, Ill.
OMC	Ohmite Manufacturing Company	Chicago 44, Ill.
PR	Precision Resistor Company	Hillside 5, N. J.
PY	Pyramid Electric Company	North Bergen, N. J.
RCA	Radio Corporation of America	Harrison, N. J.
RR	Radio Receptor Company, Inc.	Brooklyn, N. Y.
SE	Superior Electric Company	Bristol, Conn.
SGTM	Sightmaster Corporation	New Rochelle, N. Y.
SPR	Sprague Electric Company	North Adams, Mass.
ST	Sarkes Tarzian, Inc.	Bloomington, Ind.
SYL	Sylvania Electric Products, Inc.	Teterboro, N. J.
TS	Tung-Sol Electric, Inc.	Newark 4, N. J.
WL	Ward Leonard Electric Company	Mount Vernon, N. Y.



NOTES:

1. Unless otherwise specified, all capacitance values are in UF, all resistance values are in ohms.
2. Unless otherwise specified, all resistors are ½ watt.
3. Meters supplied with models 212AK, 212AMK only.
4. Unit shipped with internal jumper. For remote operation only, remove jumper.
5. ⌀ Denotes screwdriver adjustments on chassis.
6. ▭ Denotes equipment marking.
7. TB1 is supplied only on units with rear terminations.
8. On units without controls, VERNIER R19 and DC CONTROL R20 are removed and connection made directly from top of R23 (junction R23-R21) to the +REM terminal.
9. See other side of this diagram for parts list for chopper-stabilizer unit.

* terminal board removed and a MS3102A-14S-2P connector installed



Schematic Diagram, Regatron Model, 212AK, 212AMK Programmable Power Supply, Chopper-Stabilized

ELECTRICAL PARTS LIST

CHOPPER STABILIZER UNIT 336B34

REF SYMBOL	DESCRIPTION	PART OR TYPE NO.	MFR. SYMBOL
C1	Capacitor, mica, 27 UUF, 500VDC	CM19B270-J	MICAMOLD
C2	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C3	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C4	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C5	Capacitor, electrolytic, non-polarized, tantalum 20 UF, 150VDC	TAE20-25SDLK-NP	*I.E.I.
K1	Chopper, SPDT	175	AIRPAX
R1	Resistor, fixed, comp., 120K ±10%, ½W	EB	AB
R2	Resistor, fixed, comp., 33K ±10%, ½W	EB	AB
R3,R6	Resistor, fixed, comp., 4.7 MEG ±10%, ½W	EB	AB
R4	Resistor, fixed, comp., 100K ±10%, ½W	EB	AB
R5,R7	Resistor, fixed, comp., 680K ±10%, ½W	EB	AB
R8	Resistor, fixed, comp., 56K ±10%, ½W	EB	AB
R9	Resistor, fixed, comp., 270K ±10%, ½W	EB	AB
R10	Resistor, fixed, comp., 1 MEG ±10%, ½W	EB	AB
V1	Tube, 12AX7	12AX7	RCA

* *International Electronic Industries, Inc.*